

B R E V I O R A

Museum of Comparative Zoology

CAMBRIDGE, MASS.

April 6, 1956

NUMBER 52

REMARKS ON SOME MIOCENE ANURANS FROM FLORIDA, WITH A DESCRIPTION OF A NEW SPECIES OF *HYLA*

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Up to now, the only reference to Miocene anurans from Florida is by Tihen (1951), who described a new species of *Bufo* and allocated other remains to *Rana* sp. All of these fossils were collected at Thomas Farm, Gilchrist County, Florida. While washing a considerable amount of matrix from this same deposit in search of fossil snakes, a rather large number of amphibian remains were found, and these form the basis of this report. The new material permits addition of three more genera to the fauna of the Miocene, and also contributes to a better understanding of the relationships of the previously described *Bufo*.

BUFO PRAEVIUS Tihen

This toad was described on the basis of fragmentary elements of both the axial and appendicular skeletons. The relationships of *B. praeivus* were not discussed at length by Tihen, although he stated that the ilium is somewhat comparable to that in *B. terrestris* and *B. valliceps*. Considerable additional material from the same deposit contributes to our knowledge of its probable relationships. Of particular interest is the fact that there are now available cranial elements, generally considered to be quite diagnostic between species of toads. This is especially true of the orientation and degree of development of the various cranial crests. Information regarding these structures is now available for *praeivus*.

The systematic relationships of many of our North American toads have been the subject of considerable controversy during

the last few years. The present paper does not deal with the status of the species or subspecies of Recent *Bufo*, and the latest checklist (Schmidt, 1953) has been followed throughout for taxonomy.

As comparative material, a number of Recent toads have been skeletonized and examined: *Bufo t. terrestris* (23), *B. t. americanus* (1), *B. w. woodhousei* (2), *B. w. fowleri* (3), *B. valliceps* (2), *B. punctatus* (1), *B. compactilis* (1), *B. simus* (1), *B. granulatus* (1), *B. quercicus* (4), *B. perplexus* (1) and *B. pelticephalus* (1).

The ilium is considered by many workers as being of considerable value in distinguishing many genera of fossil anurans, and is the element on which the description of *B. praeivius* rests. Sixty-two additional ilia of *praeivius* have been collected at the type locality; these have been deposited in either the collections of the University of Florida (UF), or those of the Museum of Comparative Zoology (MCZ).

One of the most important characters of the ilium is the shape and degree of development of the dorsal prominence. In *praeivius* this prominence is fairly low, similar to the same structure in *B. terrestris*, *valliceps* and *woodhousei*. On the other hand, *B. compactilis* and *cognatus* (latter *vide* Tihen, *op. cit.*) have a spine-like prominence, being high, with a narrow base. This fact apparently indicates a closer relationship between *praeivius* and the *terrestris* group than with *compactilis* and/or *cognatus*. In *B. simus*, *punctatus*, *pelticephalus*, *quercicus*, *perplexus* and *granulosus* the prominence is not roughened or knob-like, but forms a smooth, well-defined, rather sharp dorsal edge.

Though the ilial prominence appears, in general, to be useful in separating natural species groups in the genus *Bufo*, changes in shape and proportions with growth are complicating factors that must be recognized. In an examination of the shape of the prominence in a series of ilia of *Bufo praeivius* now available, it is obvious that this character is more variable than indicated in Tihen's original series. As in modern *B. terrestris*, this structure may vary from very low and smooth in small specimens, to considerably higher and roughened in larger individuals.

Tihen stated that the ilial shaft of *praeivius* seemed to be less compressed than in other toads with which he compared it; but he also indicated that the degree of compression was not beyond

the range of variation found in the living forms. The diagnostic importance of this character is considerably lessened by the fact that a comparison of the degree of compression in the larger series of ilia of *praeivius* now available and a series of ilia of modern *terrestris* shows little, if any, difference between the two species.

Another character of apparent diagnostic importance is the curvature of the ilial shaft, which according to Tihen is less than that in other species of *Bufo* which he had examined, though not beyond the range of variation of modern species. This character, as well as many others, shows considerable ontogenetic change. However, the present series tends to confirm Tihen's observation, i.e., that the ilial shaft in *praeivius* is, for the most part, less curved than in most other species.

In none of the ilia is there a process on the antero-ventral edge of the acetabular expansion such as Tihen observed in one specimen (MCZ 1933). He states that although the ilium may be aberrant, it might also represent still another species of *Bufo*. A similar element has not turned up and it is highly probable that this specimen is an aberrant one.

Three fragmental urostyles were also available to Tihen, who stated that the crest was probably lower in *praeivius* than in most modern species. Although a number of fragmental urostyles have been collected, only two elements have been found complete. In these, as well as in the urostyles of two specimens of Recent *valliceps*, the height of the crest is equal to, or slightly less than the width of the articular surfaces. This crest is practically always higher than the greatest width of the anterior articular surfaces in Recent specimens of *B. t. terrestris*, *t. americanus*, *w. woodhousei* and *w. fowleri*.

A considerable number of presacral vertebrae are available for the fossil species. They do not appear to be "heavier" than those of modern species, but are seemingly identical with those of *B. terrestris* and *B. woodhousei*. A number of sacral vertebrae are also available. One sacral was found to be fused to the preceding element, forming a very symmetrical unit. This unit is clearly referable to a bufonid, most likely representing an aberrant specimen of *Bufo praeivius*.

Of particular interest in the diagnosis of modern species of toads is the shape of the cranial crests. Fortunately, cranial ele-

ments of the fossil species are now available. These include three frontoparietals (UF 9892), two temporals (UF 9893), three bones of the occipital complex and a number of squamosal stems and mandibles (UF 9894). Thus it is possible to reconstruct the major cranial ridges of the fossil form. In the following discussion the terminology used by Sanders (1953) is used throughout, since the system seems reasonable and practical.

The available frontoparietals of the fossil species are somewhat fragmentary, but indicate a number of important facts. They are cancellous and provided with well-developed crests. Furthermore, the shape and development of these crests clearly show that its relationships lie with the *terrestris-woodhousei* species complex. From above, the parietal ridges of *praeivius* are slightly diverging posteriorly. The fragmentary elements are not large enough to determine the length and size of the frontal ridges, although such ridges probably existed, as based on an examination of the anterior ends of the fragments. The parietal ridges are low anteriorly, gradually increasing in height posteriorly, much in the manner of those of *woodhousei*. From above, these ridges are relatively narrower than in *terrestris* or *houstonensis* (the latter *fide* Sanders, *op. cit.*, fig. 2), but like those in *woodhousei*. From the side they are slightly arched, as in *valliceps*, not straight as in *woodhousei*, *terrestris* or *houstonensis*. The otoparietal ridge is well-developed and rounded, being somewhat intermediate between that in *houstonensis* and *w. fowleri*. It is not as high and narrow as in *valliceps*. It is better developed than in *terrestris*, and of a different shape. The angle formed between the otoparietal and parietal ridges is approximately 90°, not greater, as in *valliceps*. The occipital groove, if present, is very inconspicuous. The otoparietal plate is not much wider than its ridge, as in *houstonensis*. However, it should be pointed out that this character, given considerable weight by Sanders (*op. cit.*), varies with age and possibly with locality in at least *B. terrestris*. The largest part of the temporal plate is cancellous, provided with a well-developed, but rounded temporal ridge. The tympanic and supratympanic ridges are definitely well developed, but to an unknown degree due to the fragmentary nature of the available elements. The parietal spur is well developed, directed backward and medially. It is not club-like as in *t. americanus*, but is similar to that in *B. woodhousei*. The shape

and position of the cranial crests in *B. praeivius* and three closely related modern species are shown in Figure 1.

From the foregoing description of additional remains of *Bufo praeivius* it is highly possible that its relationships lie with the eastern toads. This has been intimated by Tihen in regard to the ilial prominence, and is very much strengthened by the shape and

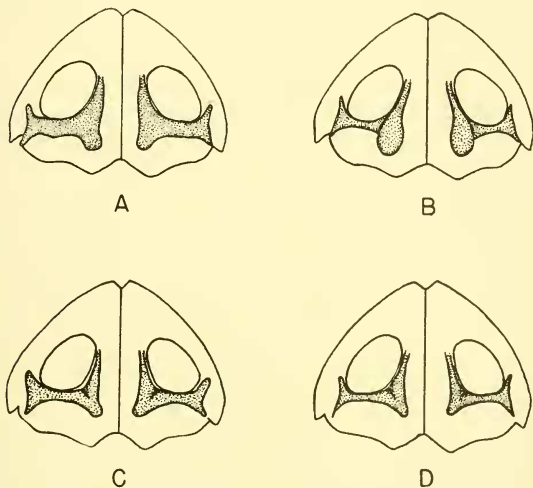


Fig. 1. Shape of the cranial crests in four species of *Bufo*. A, *Bufo houstonensis* (after Sanders, *op. cit.*); B, *Bufo t. terrestris*; C, *Bufo praeivius*; D, *Bufo w. fowleri*.

development of the cranial ridges. A few of the characters, such as the height of the urostyle crest and the arching of the parietal ridge are somewhat suggestive of *B. valliceps*. The importance of the suggested close relationship of *praeivius* to the *terrestris-woodhousei-houstonensis* complex is that it indicates that this group was already well established by early Miocene.

RANA sp.

This genus has already been reported from the Thomas Farm by Tihen (*op. cit.*). Two additional ilia are now available (UF 5919). These remains are too fragmentary to make a species identification possible, although the shape of the posterior edge of the dorsal crest is highly suggestive of the *pipiens* "group", including *palustris*, *pipiens*, *sylvatica*, *clamitans*, etc. They are not as readily referable to the group including *heckscheri*, *catesbeiana* and *grylio*.

SCAPHIOPUS cf. HOLBROOKI

In the fossil record, *Scaphiopus* is known from Pliocene (Taylor, 1941) and Pleistocene (Tihen, 1954) deposits of North America. Its occurrence in the early Miocene of Florida is thus of considerable interest.

The genus is frequently divided into two subgenera: *Scaphiopus* (including *h. holbrooki*, *h. hurteri* and *couchi*) and *Spea* (including *multiplicatus*, *bombifrons* and *hammondi*). Skeletons of all species except *multiplicatus* have been examined.

Included in the fossil material from Thomas Farm are four fragmentary ilia (UF 9896), one maxilla (UF 9897), three fragmentary frontoparietals (UF 9898) and one presacral vertebra (UF 9899), all of which appear to belong to this genus.

The ilium of the subgenus *Scaphiopus* is quite diagnostic. There is no ilial crest, and the dorsal prominence is absent or but slightly developed. When present it may exist as a small, rounded protuberance, directed dorso-laterally, about half way between the base and the end of the acetabular expansion. In the subgenus *Spea* the prominence is usually ridge-like, directed more dorsally, and contributing to the height and length of the dorsal portion of the acetabular expansion. In the fossil ilia the dorsal prominences are very small and rounded, identical with those found in the subgenus *Scaphiopus*. The disposition of the maxillary teeth, as well as the shape of the entire element, are also comparable to those of the subgenus *Scaphiopus*. There is no frontoparietal boss, such as is present in some members of the genus. On the basis of the available fossil remains, the Miocene form is not distinguishable from the modern species, *Scaphiopus holbrooki*.

Whether or not the Miocene *Scaphiopus* was identical to the species *holbrookii* cannot be absolutely determined at this time. However, the fossil form is clearly referable to the subgenus *Scaphiopus*. Whether or not the subgenus *Spica* had differentiated by this time, or whether the former is ancestral to the latter is, of course, unknown. Further collecting in other Tertiary deposits of middle North America may clarify many of our concepts regarding the ancestry of this group.

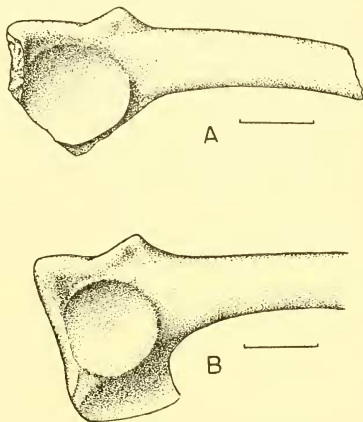


Fig. 2. Comparison of the fossil microhylid ilium from the Thomas Farm locality (A) with that of a recent specimen of *Microhyla carolinensis* (B), from Gainesville, Florida. The line represents 1 mm.

MICROHYLA sp.

Of considerable interest is the fact that one fragmental ilium from the Thomas Farm (UF 5144) apparently represents the genus *Microhyla*. Its very small size and well-developed dorsal prominence (which is triangular from the side and without any protuberances or roughened areas of any kind) are highly suggestive of this genus. In addition, the acetabular cup is very similar to that in *Microhyla*, in that the edges of the cavity are considerably raised above the surface of the acetabular expan-

sion. Although broken, the ventral portion of the acetabular expansion was apparently narrow and directed downward as in this genus. That this element does not represent a young specimen of *Bufo* is indicated in the shape of the dorsal prominence. In small specimens of *Bufo* this prominence is weakly developed, being low and long, usually with a roughened area on, or very near the dorsal edge. The genus *Microhyla* has not been reported as a fossil. Additional material, both fossil and modern, is necessary before specific identification of the fossil form will be possible (see Fig. 2).

In addition to the remains already mentioned, three ilia were found which are referable to either *Hyla*, *Pseudacris* or *Acris*. They are placed in the genus *Hyla* mainly for reasons of convenience. Neither *Acris* nor *Pseudacris* have been found as fossils. *Hyla* has been reported from the Pleistocene of North America (Brattstrom, 1953). The fossils under consideration appear to represent a new species. I wish to name this form for Dr. Coleman Goin, who has contributed materially to our knowledge of modern amphibians in life history studies, ecology and taxonomy.

HYLA GOINI nov. sp.

Diagnosis. A Miocene *Hyla* with a relatively high ilial shaft; ilium without a dorsal crest; ilial prominence rounded, well developed, with the protuberance located rather low on the prominence, projected dorsally and laterally, its anterior edge practically even with, or slightly behind the anterior edge of the acetabulum; ventral portion of the acetabular expansion broad at its base; acetabulum somewhat sub-triangular.

Holotype. MCZ 2277; the distal 7 mm. of a right ilium, collected by Walter Auffenberg, March, 1954 (Figure 3).

Horizon and Type Locality. Hawthorne formation, Lower Miocene, Arikareean; Boulder Bar, Thomas Farm, Gilchrist County, Florida.

Referred Material. UF 9900; three fragmental ilia from the same locality and horizon.

The ilia of the genera *Hyla*, *Acris* and *Pseudacris* are easily separated from those of *Rana* and *Eleutherodactylus* by the absence of a dorsal crest. From *Microhyla*, *Bufo* and *Scaphiopus* they are readily distinguished by the well-developed dorsal prom-

inence, directed dorsolaterally to laterally, and by the slenderness of the shaft itself.

The ilia of *Hyla goini* have been compared with the same element in the following genera and species: *Hyla cinerea* (12), *H. squirella* (6), *H. femoralis* (2), *H. crucifer* (2), *H. versicolor*

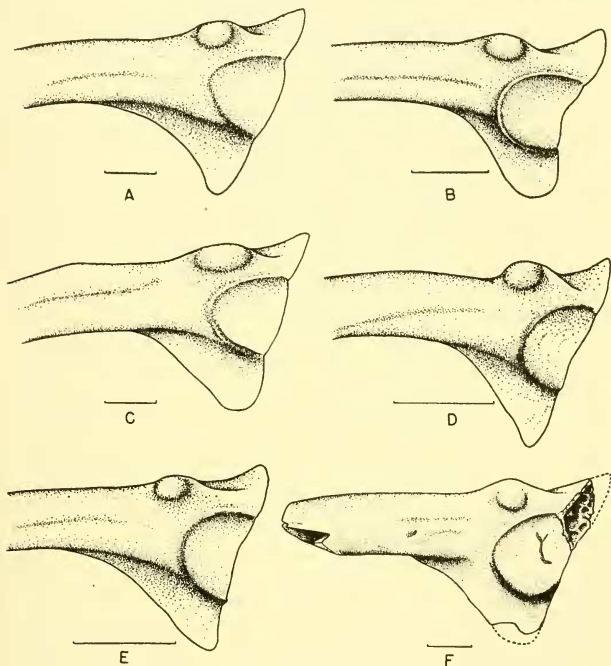


Fig. 3. Interspecific variation in the ilia of Hylidae. A, *Hyla femoralis*, 4 miles E. Gainesville, Florida; B, *Acris gryllus dorsalis*, Biven's Arm, Alachua County, Florida; C, *Hyla c. cinerea*, Gainesville, Alachua County, Florida; D, *Pseudacris ornata*, 7 mi. northeast of Gainesville, Florida; E, *Hyla crucifer bartramiana*, Camp Olena, Columbia County, Florida; F, MCZ 2277, type ilium of *Hyla goini* nov. sp., L. Miocene, Thomas Farm, Gilchrist County, Florida. The lines represent 1 mm.

(1), *H. septentrionalis* (1), *Pseudacris nigrita* (4), *P. ornata* (3), *P. brimleyi* (1), *Acris gryllus* (3).

The dorsal prominence of *Acris gryllus* is oval and on a rather long base, located in front of, to very slightly behind, the anterior edge of the acetabulum. In addition, the ventral portion of the acetabular expansion is shorter at its base than in *H. goini*. In all the hylids that I have examined, with the exception of *crucifer*, and to some extent *femoralis*, the dorsal prominence is oval, usually with a long base, and with the protuberance of the prominence located considerably higher than in *goini*. In specimens of *H. crucifer*, and some of *femoralis*, the protuberance of the dorsal prominence is relatively small, rounded, not too high, and on a fairly small base. However, the prominence in *crucifer* is anterior to the anterior edge of the acetabulum, and the lower portion of the acetabular expansion is considerably longer and narrower than in *goini*. In *femoralis* the protuberance is higher on the dorsal prominence and the acetabular expansion is also somewhat higher. In *Pseudacris nigrita*, *P. brimleyi* and *P. ornata* the dorsal prominence is rounded, never as oval as in most species of *Hyla* that I have seen. Its base is relatively short and the entire prominence is usually anterior to the anterior edge of the acetabulum. However, *goini* is considerably larger than any modern *Pseudacris*. It is apparently the size of an average specimen of *Hyla cinerea*. It also differs from modern species of *Pseudacris* that I have examined, in the shape of the acetabular expansion which is longer at its base. In addition, the somewhat subtriangular acetabulum apparently separates it from most species of this genus.

In many respects, the ilia of *Hyla* and *Pseudacris* are very similar. This is to be expected if the genera are really as closely related to one another as is generally supposed. The fossil form, *goini*, is clearly allied to one or both of these genera on the basis of its ilial shape. As a representative of the Hylidae in the Lower Miocene it could, conceivably, be ancestral to both genera. The fact that *goini* shows characters found in both modern genera may be indicative of an ancestral position, or simply a reflection of the close relationship which evidently exists between *Hyla* and *Pseudacris*. In any case, *goini* can be reasonably placed in the genus *Hyla* on the basis of its size and the fact that all of its characters are duplicated in one form or another in this genus. Ad-

ditional specimens representing other parts of the skeleton are needed before its exact status can be clearly fixed. Figure 3 compares the ilia in certain hylid frogs, selected to show the typical shape within each species, with the type of *H. goini*.

ACKNOWLEDGMENTS

For advice and criticism of this paper I wish to thank Drs. A. B. Grobman, P. Brodkorb, E. E. Williams and A. S. Romer. Acknowledgment is due Mr. L. Ogren, University of Florida, who has helped me on innumerable occasions in the field, in identifying fossil remains, and in preparing comparative skeletal material. I also wish to thank Mr. R. Highton for the loan of a number of anuran skeletons.

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